STATE OF RHODE ISLAND
DEPARTMENT OF TRANSPORTATION

GUIDELINES FOR LOAD AND RESISTANCE FACTOR RATING (LRFR) OF HIGHWAY BRIDGES

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SECTION 1 INTRODUCTION AND GENERAL OVERVIEW

1.1 INTRODUCTION

Bridge load rating is the determination of the live load carrying capacity of a newly designed or existing bridge. Load ratings are typically determined by analytical methods based on information taken from bridge plans supplemented by information gathered from field inspections or field testing. Knowledge of the capacity of each bridge to carry loads is critical for several reasons, including (but not limited to) the following:

- To determine which structures have substandard load capacities that may require posting or other remedial action.
- To assist in the most effective use of available resources for rehabilitation or replacement.
- To assist in the overload permit review process.
- FHWA requires that bridge load ratings be submitted to them annually. The NBIS (Title 23, Code of Federal Regulations, Section 650.313 (c)), requires that load ratings be in accordance with the latest AASHTO Manual. The results are used in conjunction with other bridge inventory and inspection information to determine the Federal Bridge Sufficiency Rating.

1.2 PURPOSE OF THIS DOCUMENT

This document was developed using the American Association of State Highway Officials (AASHTO) *Manual for Bridge Evaluation*, 1st Edition, 2008 with latest interims, hereinafter referred to as the MBE. This document provides guidance to load rating engineers for performing and submitting load rating calculations, posting bridges for load restrictions, and checking overweight permits using the LRFR methodology. The procedures stated in this document are to provide guidelines that will result in consistent and reproducible load rating inputs and deliverables. This document serves as a supplement to the AASHTO MBE and deals primarily with RIDOT specific load rating requirements, interpretations, and policy decisions.

LRFR is a powerful yet flexible methodology. The LRFR load rating provisions in the MBE include several evaluation factors and checks that may be considered optional based on an agency's load-rating practice. In this regard, this document provides the user best-practice recommendations for implementing the LRFR methodology. There are a number of cases in the guidelines where 'provisions' are stated as mandatory in this document, although they are optional in the MBE. The document will highlight when these cases exist/occur and provide a brief explanation why these requirements are recommended.

1.3 LOAD AND RESISTANCE FACTOR RATING METHODOLOGY

Load and Resistance Factor Rating is consistent with the LRFD Specifications in using a reliability-based limit states philosophy and extends the provisions of the LRFD Specifications to the areas of inspection, load rating, posting and permit rules, fatigue evaluation, and load testing of existing bridges. The LRFR methodology has been developed to provide uniform reliability in bridge load ratings, load postings and permit decisions. The LRFR procedures provide live load factors for load rating that have been calibrated to provide a uniform and acceptable level of reliability.

1.4 GENERAL LOAD RATING EQUATION

The general rating equation in LRFR (MBE Eq. 6A.4.2.1-1) is given as:

$$RF = \frac{\phi_c \ \phi_s \ \phi \ R_n - (\gamma_{DC})(DC) - (\gamma_{DW})(DW) \pm (\gamma_p)(P)}{(\gamma_L)(LL + IM)}$$

In the LRFR Rating Factor equation:

RF	=	Rating Factor
R_n	=	Nominal member resistance (as inspected)
ϕ_c	=	Condition Factor (Section 3.3)
ϕ_s	=	System Factor (Section 3.3)
ϕ	=	LRFD Resistance Factor
DC	=	Dead load effect due to structural components and attachments
DW	=	Dead load effect due to wearing surface and utilities
P	=	Permanent loads other than dead loads (secondary prestressing effects, etc.)
LL	=	Live load effect of the rating vehicle
IM	=	Dynamic load allowance (Section 3.2)
γ_{DC}	=	LRFD load factor for structural components and attachments
γ_{DW}	=	LRFD load factor for wearing surfaces and utilities
γ_p	=	LRFD load factor for permanent loads other than dead loads
γ_L	=	Evaluation live load factor for the rating vehicle (Section 3.2)

The load and resistance factors for evaluation are as provided in MBE Section 6 and Sections 3.2 and 3.3 of this document.

SECTION 2 GENERAL LOAD RATING REQUIREMENTS

2.1 LOAD RATING REQUIREMENTS

2.1.1 New or Reconstructed Bridges

Load ratings by the LRFR method, for the live load models defined in Section 3.2 of this document, are required for all new and replacement bridges, and for all rehabilitation and repair designs involving a substantial structural alteration. LRFR Load rating calculations shall be performed as part of the design process and reflect the bridge as-built or as-rehabilitated condition. The load rating should not include the future wearing surface as a dead load because it is not part of the as-built condition. When ratings are performed in conjunction with the preparation of design drawings, the load rating results shall be submitted in a separate load rating report at completion of construction and be based on as-built conditions. The live load distribution factor used in the design and the initial load rating shall be noted in the load rating report for use in future load ratings. Also, the Design Engineer shall provide the Load Rating Summary Sheet and the electronic input file for use in future re-analyses to the Load Rating Engineer in accordance with the requirements of Section 2.5 of this document.

2.1.2 Existing Bridges

The load rating engineer or bridge inspector shall review the bridge file after each inspection to see if a re-analysis is required and provide applicable documentation of that recommendation to the State Bridge Engineer. A revised load rating is necessary if any of the following conditions have occurred since the previous load rating:

- The primary member condition rating has changed to less than 6.
- The initial condition rating of the primary member is 5 or lower.
- Dead load has changed due to resurfacing or other non-structural alterations such as utilities.
- Section properties have changed due to deterioration, rehabilitation, re-decking or other alterations.
- Damage due to vessel or vehicular hits.
- Cracking in primary members.
- Losses at critical connections.
- Changes in traffic loadings or traffic volumes that change the load factor(s)
- Specification changes.
- Issuance of overweight permits.
- Checking of construction loads.

All existing bridges that have not been load rated previously shall be load rated at the time of the next inspection using LRFR in accordance with the requirements of this document and the MBE.

Load ratings for existing bridges should also be calculated using as-built member properties to serve as a baseline for comparative purposes.

2.2 QUALIFICATIONS AND RESPONSIBILITIES

The engineering expertise necessary to properly evaluate a bridge varies widely with the complexity of the bridge. Evaluation in accordance with this Manual shall be performed and checked by suitably qualified engineers in the type of bridges being load rated. It is expected that load rating engineers using LRFR will have a working knowledge of the LRFD Specifications and attended an NHI Course in Load Ratings or equivalent LRFR experience. Load rating analysis is an engineering evaluation that should be dated, signed and sealed by a RI licensed professional engineer.

The load rating engineer shall provide quality control of all load ratings by requiring that all load rating calculations be reviewed by a RI licensed professional engineer, other than the load rating engineer, prior to submittal to the Department. Initials of the reviewer shall be placed on each sheet of the calculations. Failure to comply with the above will be grounds for rejection by the Department

2.3 ELEMENTS TO BE LOAD RATED

The load rating shall include analysis of the following items:

- All elements defined as "primary members" as well as stringer-floorbeam, girder-floorbeam connections, and truss connections.
- Capacity of gusset plates and connection elements for non-redundant steel truss bridges
- Other connections of non-redundant systems.
- Timber and metal bridge decks.
- Concrete decks if conditions (deterioration) warrants, at RIDOT's discretion.
- Timber and metal piers elements.
- Concrete pier caps and bent caps if condition (deterioration) warrants, at RIDOT's discretion

Deteriorated bridge decks may be susceptible to punching shear failure, especially where heavy permit trucks are known to cross the bridge. Stringer supported concrete deck slabs carrying normal traffic satisfactorily need not be evaluated for load capacity.

For slab on girder bridges, the interior girder typically controls the rating, unless the deck overhang of the exterior girder is sufficiently large or the exterior girder is proportionately smaller than the interior girder. The load rating engineer will determine whether the exterior girder may control the load rating. Please note both the interior and exterior girders shall be checked to establish which governs.

Curb reveal less than 9" is considered mountable and live load shall be considered on the sidewalk.

Typically substructure elements are not routinely analyzed as part of a load rating, except as noted herein.

Capacity of connections in redundant structures shall not control load rating.

FHWA Technical Advisory T5140.29, dated January 15, 2008, recommends that during future re-calculations of load capacity on existing non-load path redundant steel bridges, the capacity of gusset plates be checked to reflect changes in condition of dead load, to make permit or posting decisions, or to account for structural modifications or other alterations that result in significant changes in stress levels. Previous load ratings should be reviewed for bridges which have been subjected to significant changes in stress levels, either temporary or permanent, to ensure that the capacities of gusset plates were adequately considered. Gusset plates and connection elements of existing non-load path redundant steel bridges that have not undergone a load capacity evaluation in the past shall be checked for compliance with Technical Advisory T5140.29. It is noted the most current procedure to evaluate gusset plate ratings from FHWA shall be used. The latest technical guidance can be obtained from FHWA’s website.

2.4 ANALYSIS AND TESTING METHODS IN LOAD RATING

Load ratings consist of computations made from design plans, as-built drawings, field measurements, and inspection reports. The load rater should review the original design plans as the first source of information for material strengths and stresses. If the material strengths are not explicitly stated on the design plans, RIDOT construction and material specifications applicable at the time of the bridge construction shall be reviewed. This may require investigations into old ASTM,, AASHTO Material Specifications, or RIDOT Standards at the time of construction. The MBE also provides guidance and data on older bridge types and materials that allows the evaluation of existing bridges.

Higher level load ratings consist of computations adjusted for actual material properties as determined from field sampling and tests of the materials. Higher level load ratings may also require the use of refined methods of analysis such as 2-D grillage or 3-D finite element models. Refined methods of analysis are justified where needed to avoid load posting or to ease restrictions on the flow of permitted overweight trucks. Some of the newer more complex structures (segmental bridges, curved-girders, integral bridges, cable-stayed, etc.) were designed using sophisticated analysis methods. Therefore a sophisticated level of analysis will be required to rate these structures.

The actual performance of most bridges is more favorable than conventional theory dictates. If directed by RIDOT, the safe load capacity for a structure can be determined from full scale non-destructive field load tests, which may be desirable to establish a higher safe load carrying capacity than calculated by analysis. Refer to the MBE Section 8 for information on conducting field load tests and using the results to establish a new or updated load rating.

In load ratings for girder bridges, the interior and exterior girders shall be checked to establish which governs.

2.5 ANALYSIS TOOLS

Standard analysis tools applicable to RIDOT bridge inventory can maximize efficiency, provide consistency, and also facilitate future revisions of Load Ratings by different parties. To this end RIDOT has specified the acceptable load rating software to be used. Use of analysis software or versions other than those listed below is subject to the approval of RIDOT.

2.5.1 BRASS

BRASS (**B**ridge **R**ating and **A**nalysis of **S**tructural **S**ystems) is a family of programs developed and maintained in the public domain by the Wyoming Department of Transportation. BRASS-GIRDER (LRFD), is a suitable program for load rating the majority of RIDOT’s bridges. It is capable of rating concrete, steel, and timber girder bridges using the LRFR methodology. It is not capable of analyzing and rating truss, arch , or curved bridges. The latest version of BRASS shall be used for all load ratings.

To provide as much consistency as possible across various structure types, and to allow for future permit load investigations in a short timeframe, RIDOT requires the use of the BRASS-GIRDER (LRFD) program for load rating the following bridge types:

- Steel girders and stringers (both composite and non-composite)
- Reinforced concrete deck girders
- Reinforced concrete box girder bridges
- Reinforced concrete slab bridges
- Reinforced concrete rigid frames
- Precast prestressed concrete girders (pre-tensioned)
- Cast-in-place post-tensioned girders
- Precast prestressed concrete slabs (multi-beam decks)

A BRASS (LRFD) input file and electronic copy of the Load Rating Report for the bridge being rated shall be submitted as part of the load rating deliverables. Please refer to the Appendix for detailed load rating deliverable information. The following live load models shall be defined in the BRASS input file for each structure rated:

Table 1. Live Loads For Load Rating

AASHTO Legal Loads	Permit Vehicles
HL-93	RI-BP1
Type 3	RI-BP2
Type 3S2	RI-BP3
Type 3-3	RI-BP4
H-20	RI-OP1
SU4	RI-OP2
SU5	RI-OP3
SU6	
SU7	

To allow for future archiving and retrieval, the complete Load Rating for each bridge shall be stored electronically in a folder named with the 6 digit bridge number (i.e. 030701). This folder shall contain all input files, a .pdf version of the complete rating report, and all other applicable backup documentation contained within the report. The process of load rating multiple live load models at the same time is important even though not all live load models may need to be evaluated per the LRFR tiered load rating process. ,Therefore, the bridge file shall contain all these additional live load rating results even when the RF for the HL-93 is greater than 1 (RF>1). However, these additional live load results are not required to be reported to the NBI by RIDOT. .

2.5.2 In-House Software / Other Commercially Available Software

Use of LRFR load rating software developed in-house or licensed from independent software vendors is subject to the approval of RIDOT. For a refined analysis, SAP structural analysis software shall be used. In addition, the latest version of MDX Software is acceptable for curved structures.

2.6 BRIDGES WITH UNKNOWN PARAMETERS

There are bridges where common analytical methods are not adequate to determine the load rating. For example, bridges where necessary details such as reinforcement in a concrete bridge are not available from plans or field measurements, knowledge of the live load used in the original design, the current condition of the structure, and live load history may be used to provide a basis for assigning a safe load capacity. A concrete bridge with unknown details need not be posted for restricted loading if it has been carrying normal traffic and shows no visible distress. Nondestructive proof load tests can be helpful in establishing the safe load capacity for such structures. Section 8 of the MBE provides guidance on the use of proof load tests, the interpretation of load test results, and the types of bridges that are suitable candidates for proof load tests. Proposed proof load tests, if required, shall be reviewed and approved by RIDOT. In these circumstances, the load rating engineer shall document in their recommendations if a structure should be proof tested to assist in determining the safe load carrying capacity of the structure. Also, this recommendation shall be "checked" on the "Summary of Bridge Rating" sheet provided in the load rating report.

2.7 REPORTING LRFR TO THE NBI

For all new load ratings based on the LRFR methodology, the load rating data shall be reported to the NBI as a Rating Factor, for items 63, 64, 65 and 66, using the HL-93 loadings.

2.8 TIMBER BRIDGES

Load rating of timber bridge components shall be performed in accordance with MBE Section 6A.7.

2.9 EVALUATION OF CONCRETE BRIDGES FOR SHEAR

MBE 6A.5.9 states that in-service concrete bridges that show no visible signs of shear distress need not be checked for shear when rating for the design load or legal loads. However, RIDOT requires the shear capacity of all existing reinforced and prestressed concrete bridge members be evaluated for the design load, AASHTO legal loads, and permit loads as described in Section 2.5.1. The implication of MBE 6A.5.9 is that a posting decision does not have to be dictated by the legal load rating results for shear for concrete bridges that show no visible signs of shear distress.

SECTION 3 LOAD AND RESISTANCE FACTOR RATING GUIDELINES

3.1 DATA COLLECTION FOR LRFR LOAD RATING

3.1.1 Review of Existing Bridge Plans and Documents

As-built plans are contract design plans which have been modified to reflect changes made during construction. As-built plans are used to determine loads, bridge geometry, section and material properties. Shop drawings are also useful sources of information about the bridge. Plans may not exist for some bridges. In these cases, complete field measurements of the structure will be required. Contract design plans and standard drawings used for construction are generally identified in the roadway plans for the project under which the bridge was built. These plans can be obtained from the RIDOT Plan Room. Other appropriate bridge history records, testing reports, repair or rehabilitation plans should be reviewed to determine their impact on the load carrying capacity of the structure.

3.1.2 Bridge Inspection for Load Rating

Bridges being investigated for load capacity must be inspected for condition as per the latest edition of the MBE and the FHWA *Bridge Inspector's Reference Manual*. Bridge inspections are conducted to determine the physical and functional condition of the bridge; to form the basis for the evaluation and load rating of the bridge, as well as analysis of overload permit applications. The inspector must verify the accuracy of existing plans or sketches with field measurements. It is especially important to measure and document items that may affect the load capacity, such as dead loads, section deterioration, and damage. Only sound material should be considered in determining the nominal resistance of the deteriorated section. Where present, utilities, attachments, depth of fill, and thickness of wearing surface should be field verified at the time of inspection. Wearing surface thicknesses are also highly variable. Multiple measurements at curbs and roadway centerline should be used to determine an average wearing surface thickness. Load factor for DW at the strength limit state may be taken as 1.25 where thickness has been field measured.

3.1.3 Assessment of Truck Traffic Conditions at Bridge Site

LRFR live load factors appropriate for use with legal loads and permit loads are defined based upon the Average Daily Truck Traffic (ADTT) available or estimated volumes for the bridge site. FHWA requires an ADTT to be recorded on the Structural Inventory and Appraisal (SI&A) form for all bridges. In cases where site traffic conditions are unavailable from the bridge file, the RIDOT Traffic Section should be contacted for current ADTT information for the route carried by the bridge or routes with a similar functional classification. ADTT may also be estimated from Average Daily Traffic (ADT) data for the site. If fatigue controls the load rating site specific ADTT may be considered.

3.1.4 Selection of Surface Roughness Rating

LRFD dynamic load allowance of 33% reflects conservative conditions that may prevail under certain distressed approach and bridge deck conditions. For load rating of legal and permit vehicles for bridges with less severe approach and deck surface conditions, the dynamic load allowance (IM) may be decreased based on field observations in accordance with MBE Table C6A.4.4.3-1 (See LRFD Section 3.6.2). The inspector should carefully note these and other surface discontinuities in order to benefit from a reduced dynamic load allowance. Dynamic load allowance need not be applied to timber bridge components.

To ensure proper and consistent selection of dynamic load allowance values in all load ratings, the load rating engineer should assign a rating for the surface roughness of the bridge riding surface based on his field review and notes. This rating value shall be documented in the load rating report. Surface Roughness is defined as follows:

Table 2. Surface Roughness Rating

Surface Roughness Rating	Description
3 = Smooth	Smooth riding surface at approaches, bridge deck, and expansion joints
2 = Average	Minor surface deviations or depressions
1 = Poor	Significant deviations in riding surface at approaches, bridge deck, and expansion joints

The dynamic load allowance shall not exceed 20% for permit loads above 150,000 lbs, and eliminated entirely for slow moving permit loads (< 5 mph).

3.2 LIVE LOAD FACTORS

3.2.1 Overview of LRFR Load Rating Process for RIDOT Bridges

Live loads to be used in the rating of bridges are selected based upon the purpose and intended use of the rating results. Live load models outlined below shall be evaluated for the Strength, Service and Fatigue limit states in accordance with Table 3:

1) Design load rating is a first-level rating performed for all bridges using the HL-93 loading at the Inventory (Design) and Operating levels.
2) Rate for the AASHTO Legal trucks Type 3, Type 3S2, Type 3-3, H20, SU4, SU5, SU6, and SU7. (Legal lane loads are to be used for spans greater than 200 ft and for negative moment areas as given in Figure D6A-4 and Figure D6A-5 respectively.
3) Rate for the standard permit vehicles as given in Section 3.2.4 of this document for future permitting operations. Other overweight permit vehicles that deviate significantly from the standard permit vehicles are to be evaluated on a case by case basis. These standard permit vehicles assist RIDOT in the review of overweight permits..

Table 3. LRFR Limit States

Bridge Type	Limit State	HL-93 Load	AASHTO Legal Loads	Permit Loads
Steel	Strength I	●	●	
	Strength II			●
	Service II	●	●	●
	Fatigue	●		
Reinforced Concrete	Strength I	●	●	
	Strength II			●
	Service I			●
Prestressed Concrete (non-segmental)	Strength I	●	●	
	Strength II			●
	Service III	●	●	●
	Service I			●
Timber	Strength I	●	●	
	Strength II			●

3.2.2 Strength Rating for HL-93 Loading

The design-load rating (or HL-93 rating) assesses the performance of existing bridges utilizing the LRFD HL-93 design loading and design standards with dimensions and properties for the bridge in its present as-inspected condition. It is a measure of the performance of existing bridges to new bridge design standards contained in the LRFD Specifications. The design-load rating produces Inventory and Operating level rating factors for the HL-93 loading. The evaluation live-load factors for the Strength I limit state shall be taken as given in MBE Table MBE 6A.4.3.2.2-1.

Table MBE 6A.4.3.2.2-1 Load Factors for Design Load: γ_L.

Evaluation Level	Load Factor
Inventory	1.75
Operating	1.35

The dynamic load allowance specified in the LRFD Specifications for new bridge design (LRFD Article 3.6.2) shall apply. For the design load rating, regardless of the riding surface condition or the span length, always use 33% for the dynamic load allowance (IM).

The results of the HL-93 rating are to be reported to the NBI as a Rating Factor.

3.2.3 Strength Rating for AASHTO Legal Loads (Type 3, Type 3S2, Type 3-3, SU4, SU5, SU6, SU7) and H-20

In LRFR, load rating for legal loads determines a single safe load capacity of a bridge. The previous distinction of Operating and Inventory level ratings is no longer maintained when load rating for legal loads.

MBE APPENDIX D6A

AASHTO LEGAL LOADS

a) AASHTO Trucks—Apply for all span lengths and load effects.

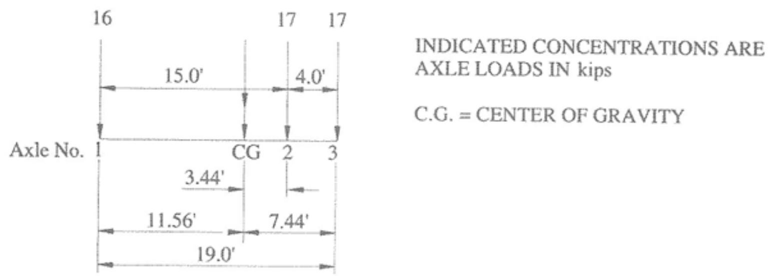

Figure D6A-1 Type 3 Unit Weight = 50 kips (25 tons).

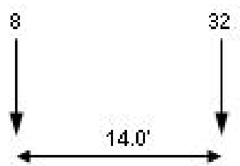

Figure H20 Weight = 40 kips (20 tons).

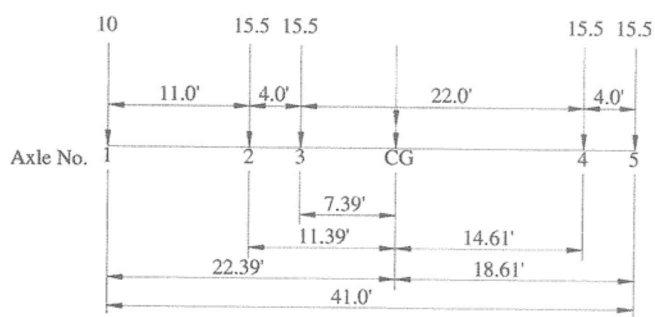

Figure D6A-2 Type 3S2 Unit Weight = 72 kips (36 tons).

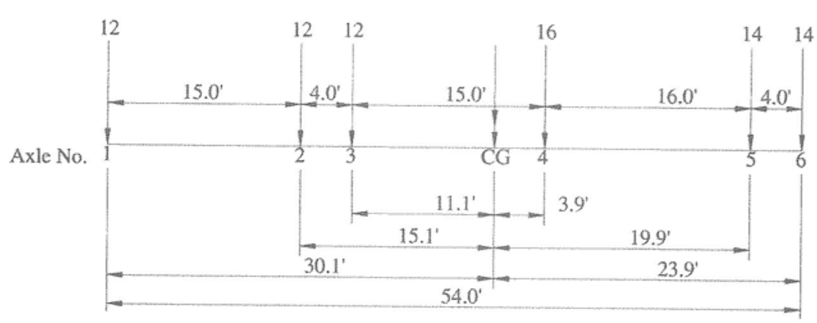

Figure D6A-3 Type 3-3 Unit Weight = 80 kips (40 tons).

APPENDIX A-6A.4 (continued)

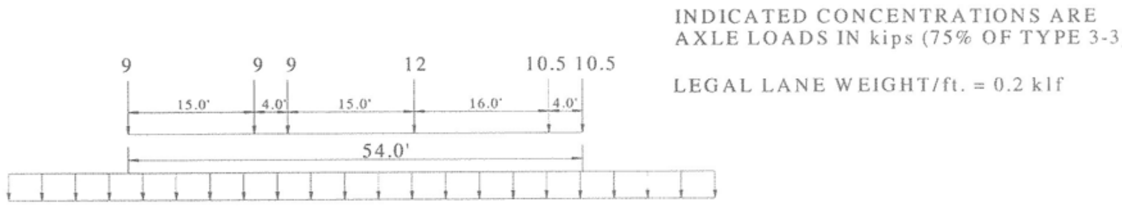

Figure D6A-4 Lane-Type Loading for Spans Greater than 200 ft.

c) Lane-Type Legal Load Model—Apply for negative moment and interior reaction for all span lengths.

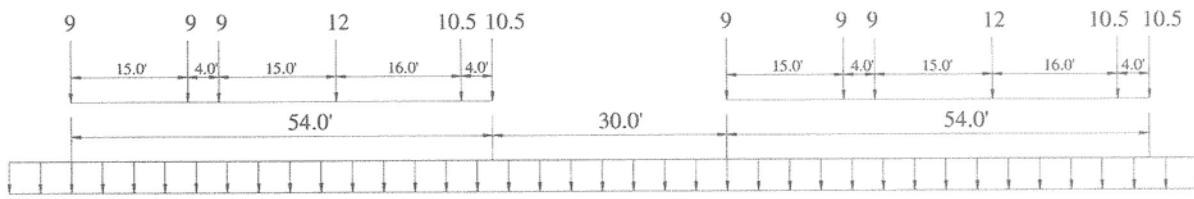

Figure D6A-5 Lane-Type Loading for Negative Moment and Interior Reaction.

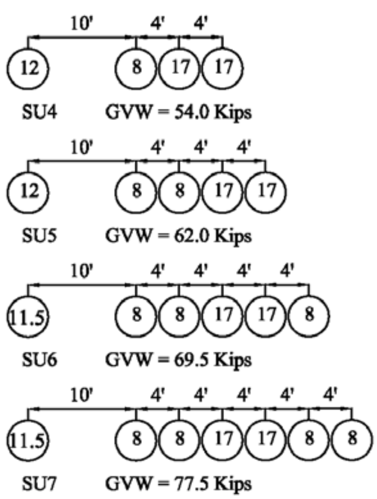

Figure D6A-7 Bridge Posting Loads for Single-Unit SHV's that Meet Federal Bridge Formula B

3.2.4 Strength Rating for Overweight Permits

SINGLE TRIP PERMITS: Permits for single trip movements are issued for one-way or round-trip movement of overweight vehicles. These permits are valid only for the specific date, time, vehicle, and route designated in the permit.

Single trip permit analysis shall be performed for a single lane loading. This is used because these permit loads are infrequent and are likely the only heavy loads on the structure during the crossing. When one-lane LRFD distribution factor is used, the built-in 1.2 multiple-presence factor should be divided out (That is, divide the computed one-lane distribution factor by 1.2

before using in the permit load rating). The permit vehicle shall be placed laterally on the bridge, within the striped lanes, to produce maximum stresses in the critical member under consideration. In special cases the dynamic load allowance may be neglected provided that the maximum vehicle speed can be reduced to 5 MPH prior to crossing the bridge. Also, in some cases, the truck may be escorted across the bridge with no other vehicles allowed on the bridge during the crossing. If this is the case, then the live load factor can be reduced from 1.5 to 1.15 as shown in Table 4.

ROUTINE PERMITS: Routine permits are issued for the movement of overweight vehicles over a specified route or within a restricted area. The duration of the permit shall not be more than one year, and the movements shall be made during the hours specified in the permit.

Routine permits are usually valid for unlimited trips over a period not to exceed one year. The permit vehicle may mix in the traffic stream and move at normal speeds without any restrictions.

The evaluation live-load factors for permits for the Strength II limit state shall be taken as given in Table 4. (MBE Table 6A-4.5.4.2A-1):

Table 4. Permit Load Factors

					Load Factor by Permit Weight[b]	
Permit Type	Frequency	Loading Condition	DF^a	ADTT (one direction)	Up to 100 kips	≥150 kips
Routine or Annual	Unlimited Crossings	Mix with traffic (other vehicles may be on the bridge)	Two or more lanes	>5000	1.80	1.30
				=1000	1.60	1.20
				<100	1.40	1.10
					All Weights	
Special or Limited Crossing	Single-Trip	Escorted with no other vehicles on the bridge	One lane	N/A	1.15	
	Single-Trip	Mix with traffic (other vehicles may be on the bridge)	One lane	>5000	1.50	
				=1000	1.40	
				<100	1.35	
	Multiple-Trips (less than 100 crossings	Mix with traffic (other vehicles may be on the bridge)	One lane	>5000	1.85	
				=1000	1.75	
				<100	1.55	

Note: a) When one-lane distribution factor is used, the built-in 1.2 multiple presence factor should be divided out. Linear interpolation is permitted for other ADTT

b) For routine permits between 100 kips and 150 kips, interpolate the load factor by weight and ADTT value. Use only axle weights on the bridge.

3.2.4.1 Standard Single Trip Permit Vehicles for Load Rating

The standard permit vehicles shown in Figure 2 represent classes of overweight trucks most frequently used to carry loads requiring a single trip permit. The permits in Fig 2 were chosen by reviewing past permit applications received by RIDOT and by comparing the load effects induced by the various truck configurations in each permit class to extract a small number of representative vehicles as standard permits. For any bridge re-rating, the standard permit vehicles shall be analyzed as additional live load models. The results will be available for informational and future permit management and operations purposes (need not to be used for load restriction purposes).

For most future permit load investigations, the results of the standard permit vehicles will provide a sound basis for screening the load for bridge safety without the need for a re-analysis. For specific Single Trip permit applications where the truck may not fit the standard permit configurations, the actual truck configuration described in the permit shall be the live load used to analyze all pertinent structures. In the future, RIDOT may define additional standard permit vehicles based upon the frequency of such permits and their potential to induce load effects outside the envelope of the other standard permit vehicles.

Single Trip Overweight Permit load analysis assumes only one permit load on the bridge, which allows the use of the single-lane distribution. As stated in the footnote of Table 4, when using a single-lane LRFD distribution factor, the 1.2 multiple-presence factor should be divided out from the distribution factor equations. For girder bridges, the interior and exterior girders shall be checked to see which governs. For single trip permit vehicles, it is important to note that the vehicle could traverse the bridge in any lane, making it necessary to investigate whether the exterior girder controls the load rating.

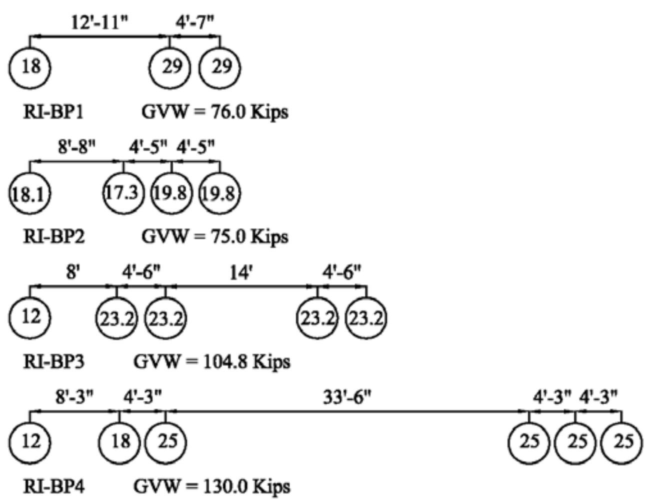

Figure 1. RI Blanket Permit Vehicle Configurations (Unlimited Crossings)

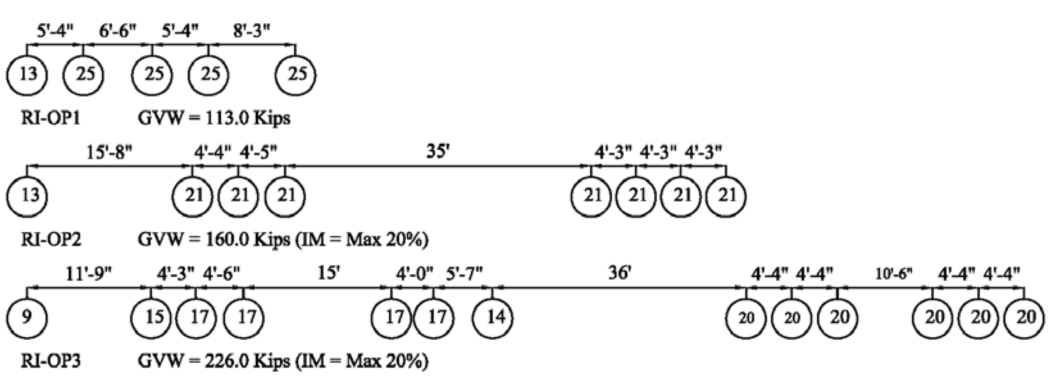

Figure 2. RI Overweight Permit Vehicle Configurations (Single Trips)

3.2.5 Reduced Dynamic Load Allowance for Rating (Legal and Permit Loads)

For legal and permit vehicle ratings of longitudinal members, having spans greater than 40 ft. with less severe approach and deck surface conditions, the Dynamic Load Allowance (IM) may be decreased from the LRFD design value of 33%, as given below in Table 5, for the Strength and Service limit states. Dynamic load allowance shall be applied to the AASHTO legal vehicles and not the lane loads. Regardless of riding surface condition, always use 33% for spans 40 ft or less and for transverse members. Selection of IM shall be in accordance with the requirements of Section 3.1.4 and the Surface Roughness rating noted in the inspection report. State or document what value of IM was used for the load rating in the Load Rating Summary Form.

Table 5 Dynamic Load Allowance for Rating: IM.

Riding Surface Rating	IM
3	10%
2	20%
1	33%

The dynamic load allowance shall not exceed 20% for permit loads above 150,000 lbs, and eliminated entirely for slow moving permit loads (< 5 mph).

3.3 RESISTANCE FACTORS AND RESISTANCE MODIFIERS FOR THE STRENGTH LIMIT STATES

3.3.1 Resistance Factor: ϕ

For Strength Limit States, member capacity is given as:

$$C = \phi_c \ \phi_s \ \phi \ Rn$$

Where:
ϕ_c = Condition Factor (Table MBE 6A.4.2.3-1)
ϕ_s = System Factor (Table MBE 6A.4.2.4-1)
ϕ = LRFD Resistance Factor

Where, the following lower limit shall apply:

$$\phi_c \ \phi_s \ \geq \ 0.85$$

Resistance factor φ has the same value for new design and for load rating. Resistance factors, φ, shall be taken as specified in the LRFD Specifications for new construction. A reduction factor based on member condition, Condition Factor ϕ_c, is applied to the resistance of degraded members. An increased reliability index is maintained for deteriorated and non-redundant bridges by using condition and system factors in the load rating equation.

3.3.2 Condition Factor: ϕ_C

The condition factor provides a reduction to account for the increased uncertainty in the resistance of deteriorated members and the likely increased future deterioration of these members during the period between inspection cycles. Current RIDOT policy is to set this factor equal to the values presented in Table MBE 6A.4.2.3-1.

Table MBE 6A.4.2.3-1 Condition Factor: ϕ_C .

Superstructure Condition Rating (SI & A Item 59)	Equivalent Member Structural Condition	ϕ_C
6 or higher	Good or Satisfactory	1.00
5	Fair	0.95
4 or lower	Poor	0.85

The Condition Factor ϕ_C does not account for section loss, but is used in addition to section loss. If section properties are obtained accurately, by actual field measurement of losses rather than by an estimated percentage of losses, the values specified for ϕ_C in Table 6A.4.2.3-1 may be increased by 0.05 ($\phi_C \leq 1.0$). For instance, a concrete member may receive a low condition rating due to heavy cracking and spalling or due to the deterioration of the concrete matrix. Such deterioration of concrete components may not necessarily reduce their calculated flexural resistance. But it is appropriate to apply the reduced condition factor in the LRFR load rating analysis. If there are also losses in the reinforcing steel of this member, they should be measured and accounted for in the load rating. It is appropriate to also apply the reduced condition factor in the LRFR load rating analysis, even when the as-inspected section properties are used in the load rating as this reduction by itself does not fully account for the impaired resistance of the concrete component.

In the MBE, the use of Condition Factors is considered optional based on an agency's load-rating practice. This document requires their use in LRFR load ratings for RIDOT.

3.3.3 System Factor: ϕ_S

System factors are multipliers applied to the nominal resistance to reflect the level of redundancy of the complete superstructure system. Bridges that are less redundant will have their factor member capacities reduced, and, accordingly, will have lower ratings. The aim of the system factor is to provide reserve capacity for safety of the traveling public. RIDOT policy is to use the system factors provided in Table MBE 6A.4.2.4-1 when load rating for Flexural and Axial Effects for steel members and non-segmental concrete members. The system factor is set equal to 1.0 when checking shear. Subsystems that have redundant members should not be penalized if the overall system is non-redundant (i.e. multi stringer deck framing members on a two-girder or truss bridge). System Factor is used with all live load models.

Table MBE 6A.4.2.4-1 System Factor: ϕS for Flexural and Axial Effects

Superstructure Type	ϕ_S
Welded Members in Two-Girder/Truss/Arch Bridges	0.85
Riveted or Bolted Members in Two-Girder/Truss/Arch Bridges	0.90
Multiple Eyebar Members in Truss Bridges	0.90
Multiple Girder Bridges and Slab Bridges	1.00
Floorbeams with Spacing >12ft. and Non-Continuous Stringers	0.85
Redundant Stringer Subsystems Between Floorbeams	1.00

<u>Definitions</u>

Floorbeam – A horizontal flexural member located transversely to the bridge alignment.
Stringer -- A longitudinal beam supporting the bridge deck.

Girder – A large flexural member, usually built-up, which is the main or primary support for the structure, and which usually receives load from floorbeams, stringers, or in some cases directly from the deck.

The system factors in Table 6A.4.2.4-1 are more conservative than the LRFD-design values. This document requires their use in LRFR load ratings for RIDOT.

3.4 RESISTANCE FACTORS AND RESISTANCE MODIFIERS FOR THE SERVICE LIMIT STATES

For all non-strength limit states, φ =1.0, ϕ_c = 1.0, ϕ_s = 1.0

3.5 SERVICE AND FATIGUE LIMIT STATES FOR LOAD RATING

3.5.1 General Overview

Strength is the primary basis for evaluation. The focus of serviceability checks in evaluation is to identify and control live load effects that could potentially damage the bridge structure, and impair its serviceability and service life. The MBE recommends applicable service limit states for LRFR evaluation and permits. This document recommends the systematic evaluation of all recommended service and fatigue limit states as described herein as the results of these evaluations could provide important guidance for future inspection and maintenance activities. Certain serviceability checks may also govern the review of overweight permits.

Service and fatigue limit states to be evaluated during a load rating analysis shall be as given below in Table 6:

Table 6 LRFR Service and Fatigue Limit States and Load Factors

Bridge Type	Limit State	Dead Load	Dead Load	Design Load		Legal Load	Permit Load
				Inventory	Operating		
		DC	DW	LL	LL	LL	LL
Steel	Service II	1.00	1.00	1.30	1.00	1.30	1.00
	Fatigue	0.00	0.00	0.75	—	—	—
Reinforced Concrete	Service I	1.00	1.00	—	—	—	1.00
Prestressed Concrete (non-segmental)	Service III	1.00	1.00	0.80	—	1.00	1.00
	Service I	1.00	1.00	—	—	—	1.00

3.5.2 Concrete Bridges

- For non-segmental prestressed concrete bridges, LRFR provides a limit state check for cracking of concrete (SERVICE III) by limiting concrete tensile stresses under service loads. SERVICE III check shall be performed during design load, legal load, and permit load ratings of prestressed concrete bridges. No tension stresses are allowed in the precompressed tensile zone when performing the design load check at the Inventory level. The allowable tensile stress precompressed tensile zone for the Operating level design load check, legal load ratings, and permit load ratings shall be $0.19\sqrt{f_c'}$. in KSI units.

- Service I and Service III limit states are mandatory for load rating of segmental concrete box girder bridges (MBE 6A.5.13.5.1).
- A new SERVICE I load combination for reinforced concrete components and prestressed concrete components has been introduced in LRFR to check for possible inelastic deformations in the reinforcing steel during heavy permit load crossings (MBE 6A.5.4.2.2). This check shall be applied to permit load checks and sets a limiting criterion of $0.9F_y$ in the extreme tension reinforcement. Limiting steel stress to $0.9F_y$ is intended to ensure that there is elastic behavior and that cracks that develop during the passage of overweight vehicles will close once the vehicle is removed. It also ensures that there is reserve ductility in the member.

3.5.3 Steel Bridges

Steel structures shall satisfy the overload permanent deflection check under the SERVICE II load combination for design load, legal load and permit load ratings using load factors as given in Table 6. Maximum steel stress is limited to 95% and 80% of the yield stress for composite and non-composite compact girders respectively. During an overweight permit review the actual truck weight is available, so a 1.0 live load factor is specified.

In situations where fatigue-prone details are present (category C or lower) a Fatigue limit state Rating Factor for infinite fatigue life shall be computed. If directed by RIDOT, bridge details that fail the infinite-life check can be subject to the more complex finite-life fatigue evaluation using evaluation procedures given in the MBE (Section7).

SECTION 4 LRFR LOAD POSTING GUIDELINES

4.1 LOAD POSTING REQUIREMENTS FOR BRIDGES

NBIS regulations (23 CFR Part 650) require the rating of each bridge as to its safe loading capacity in accordance with the MBE and the posting of the bridge in accordance with this document or in accordance with state law, when the maximum unrestricted legal loads or state routine permit loads exceed that allowed under the Operating rating. If a bridge is not capable of carrying statutory loads, it is posted for a lesser load limit. The decision to load post a bridge will be made by the bridge owner based on an agency's load-posting practice. The LRFR guidelines are provided to assist RIDOT and local bridge owners for establishing posting weight limits.

All posting decisions must be based on the results of a current field inspection and LRFR load rating. Bridges which cannot carry the maximum weight for the vehicles described in the legal load rating criteria are posted with one of the standard signs showing the bridge capacity for the governing vehicle(s). Authority to post or close a bridge is maintained by the bridge owner, conforming to local regulations or policy, within the limits established by the MBE.

Strength limit state is used for checking the ultimate capacity of structural members and is the primary limit state utilized by RIDOT for determining posting needs. Service and fatigue limit states are utilized to limit stresses, deformations, and cracking under regular service conditions. In LRFR, Service and Fatigue limit state checks are optional in the sense that a posting or permit decision is dictated by the result. These serviceability checks provide valuable information for the engineer to use in the decision process.

A concrete bridge with unknown details need not be posted for restricted loading if it has been carrying normal traffic and shows no distress (see Section 2.6).

4.2 RELIABILITY-BASED POSTING

The goal of the LRFR methodology is to maintain target uniform reliabilities in all load ratings and load postings. Unlike past practice, it should be noted that in a reliability-based evaluation the relationship between posting values and rating factors is not proportional. For a posted bridge, there is a greater probability of vehicles exceeding the posted limit compared to numbers exceeding the legal limit on an un-posted bridge. The MBE provides guidance on how to translate LRFR rating factors less than 1.0 into posting values that maintain the criteria of uniform reliability, especially for the low-rated bridges. This is achieved through a posting analysis equation, Eq. 6A.8.3-1 and a posting graph given in the MBE that presents posting weights for different vehicle types as a function of LRFR rating factors.

4.3 POSTING ANALYSIS

When for any legal truck the RF is between 0.3 and 1.0, then the following equation should be used to establish the LRFR posting load for that vehicle type:

$$\text{LRFR Posting Load} = \frac{W}{0.7}\left[\left(RF\right) - 0.3\right] \qquad \text{MBE Eq. (6A.8.3-1)}$$

Where:

RF = Legal load rating factor
W = Weight of rating vehicle (Tons)

The Load Rating Engineer shall make a recommendation as to the need for posting and the weight limit for posting should posting be required. When the RF for any vehicle type falls below 0.3, then a recommendation should be made to not allow that particular vehicle type on the bridge. Other vehicle types with RF > 0.3 may continue to use the bridge. Posting recommendations shall be added to the Load Rating Summary sheet.

Bridges that are determined not capable of carrying 3 tons shall be closed.

SECTION 5 LOAD RATING DELIVERABLES

5.1 LOAD RATING REPORT

Load rating calculations and documentation shall be incorporated into a comprehensive report to facilitate updating the information and calculations in the future. The load rating should be completely documented in writing including all background information such as field inspection reports, material and load test data, all supporting computations, and a clear statement of all assumptions used in calculating the load rating. Sketches shall be provided to document section losses incorporated in the analysis. Inspection reports, testing reports, and articles referenced as part of the load rating shall be documented. However, all structures do not need a detailed inspection prior to the load rating being performed. State inspection reports shall be reviewed to determine if deficiencies are noted which may affect the rating.

When refined methods of analysis or load testing are used, the load rating report shall include live load distribution factors for all rated members, determined through such methods. For more complex structures where computer models are used in the analysis, a copy of the computer models with documentation shall be made and submitted to RIDOT. For new, replaced and rehabilitated bridges designed using LRFD, the LRFR ratings shall be computed at the time of design.

Load rating procedures and deliverables specified in this document are more extensive than are usually required. The procedures are considered more cost-effective in the long term considering the ease in updating the ratings when re-rating is necessary in the future. The automated processes with an established load library will provide the complete level of information to base future permit decisions. The requirements are geared to maximizing efficiency and providing consistency in load ratings.

The Rating Report shall be printed on 8½”x11” sheets and shall be GBC bound with clear front and back covers. The font size of the Bridge Number shall be such as to permit easy recognition. Fold-out pages greater than 8½”x11” size shall not be included. An electronic version of the load rating report(.pdf), including the BRASS input data file and any computer models used in the analysis, shall be submitted to RIDOT on a CD/DVD along with one (1) hard copy. The CD/DVD shall be attached to the inside of the back cover. **Covers shall be in red if any rating is 10 tons or less, yellow if more than 10 tons but less than statutory and green for statutory or greater.** It shall be noted the color of the cover sheet is independent of the controlling limit state and is strictly based on the controlling rating factors regardless of what controls the posting. The Rating Report shall be composed of the following sections:

Table 7. Load Rating Report Layout

Order	**Description**	**Comments**	**Reference Sheet No.**
1	Report Cover	PE Stamp to be included	23
2	Title Sheet	White copy of Report Cover	23
3	Index	Index of Sections with page numbers	
4	Summary of Bridge Rating	PE Stamp to be included Tabular listing of all controlling rating values	24
5	Breakdown of Bridge Rating	Tabular listings of Inventory and Operating (if applicable) of all bridge elements at all critical locations.	25,26,27,28, 29
6	Location Map	Location map shall provide sufficient landmarks and roadway information to allow user to find the structure without any additional information.	
7	Description of Bridge	Tabular listing of pertinent bridge information at time of load rating.	30
8	Rating Analysis Assumptions and Criteria	Description of all methods, assumptions, strengths, and standards used to determine rating of structure	
9	Evaluation of Rating Recommendations	Summary of controlling elements of the structure and recommendations to either improve or maintain the condition of the structure.	
10	Reference & Available Plans	List of all References (manuals, computer software/version, etc) List of Plans used to prepare the load rating.	
11	Truck Loadings	Diagram and description for all truck types in the Rating.	
12	Appendix A (Inspection Report)	SI&A Inspection Report with notes. This report must be the latest available inspection report.	
13	Appendix B (Photos)	An appropriate number of color photographs of the structure (two pictures per 8 ½" x11" sheet), including both elevation and approach views, framing views (if it varies, one of each type) and sufficient critical member photos. An index of all photos shall precede the photos	
14	Appendix C (Computations)	Computations shall include an index, sketches, hand calculations, and the written agreement of the independent reviewer.	
15	Appendix D (Computer Input/Output)	A summary sheet of all rating factors and rating values for each structure's particular element shall be created and placed in front of each computer output of each particular element. Also, hard copies of all input and output summary pages including software generated sketches of computer programs used in rating the structure. These hard copies shall be submitted *double-sided* and *two-output pages per-side* in order to conserve paper.	

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Bridge Load Rating

Prepared for

Rhode Island
Department of Transportation

[CITY/TOWN]
[ROUTE CARRIED]
OVER
[CROSSING]

Bridge No. [INSERT BRIDGE NUMBER]

Date of Inspection: [LATEST INSPECTION DATE]
Date of Rating: [DATE RATING SUBMITTED]

Prepared By:
[CONSULTANT NAME & ADDRESS]

[INSERT P.E. STAMP]

Figure 3. Load Rating Report Cover Sheet

SUMMARY OF BRIDGE RATING

Town/City:	[INSERT LOCATION]
Route Carried:	[INSERT ROUTE]
Owner:	[STATE/TOWN]
Maintained By:	[STATE/TOWN]
Bridge No.:	[INSERT NO.]
Crosses:	[INSERT]
Year Built:	[INSERT YEAR]
Year(s) Rebuilt/Rehab:	[INSERT YEAR(s)]

RATING

VEHICLE TYPE		RF	RL (TONS)	POSTING
HL-93	INV	[X]	[X]	---
	OPER	[X]	[X]	---
H20		[X]	[X]	[X]
TYPE 3		[X]	[X]	[X]
TYPE 3S2		[X]	[X]	[X]
TYPE 3-3		[X]	[X]	[X]
SU 4		[X]	[X]	[X]
SU 5		[X]	[X]	[X]
SU 6		[X]	[X]	[X]
SU 7		[X]	[X]	[X]
RI-BP 1		[X]	[X]	[X]
RI-BP2		[X]	[X]	[X]
RI-BP 3		[X]	[X]	[X]
RI-BP 4		[X]	[X]	[X]
RI-OP1		[X]	[X]	[X]
RI-OP2		[X]	[X]	[X]
RI-OP3		[X]	[X]	[X]

Note: Shaded boxes apply to Service Limit State

LRFR Evaluation Factors	
Surface Roughness Rating:	
Governing Condition Factor, ϕ_c:	
System Factor, ϕ_s:	
ADTT (One-Way):	

Posting Analysis	
Posting Recommendation (Y/N):	
Governing RF:	
Governing Load Model:	

QA/QC	
Load Rating Engineer Name:	
Load Rating Engineer License #:	
Load Rating Engineer Signature:	
Load Rating Checked By:	
Quality Assurance By:	
Load Rating Date:	

Please check the following boxes that apply:

- [ ] Bridge load rating is not governed by deck rating
- [ ] Bridge load rating is not governed by substructure rating
- [ ] Connections do not control the load rating
- [ ] Exterior girder controls the load rating
- [ ] Bridge plans do not exist; load rating based on judgement and current rating
- [ ] As-built load rating
- [ ] As-inspected load rating
- [ ] Recommend Proof load test due to limited available information (Note: only if bridge requires posting)

Figure 4. Load Rating Report Summary Sheet

BREAKDOWN OF BRIDGE RATING

Town/City:	[INSERT LOCATION]	Bridge No.:	[INSERT NO.]
Route Carried:	[INSERT ROUTE]	Crosses:	[INSERT]
Owner:	[STATE/TOWN]	Year Built:	[INSERT YEAR]
Maintained By:	[STATE/TOWN]	Year(s) Rebuilt/Rehab:	[INSERT YEAR(s)]

INVENTORY RATING LOAD (LEGAL LOADS)

BRIDGE COMPONENT	DESIGN LOAD (HL-93)	LEGAL LOAD (TONS)							
		H20	TYPE 3	TYPE 3S2	TYPE 3-3	SU 4	SU 5	SU 6	SU 7
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]

Figure 4. Load Rating Report Breakdown of Bridge Rating (Inventory for Legal Loads)

BREAKDOWN OF BRIDGE RATING

Town/City:	[INSERT LOCATION]	Bridge No.:	[INSERT NO.]
Route Carried:	[INSERT ROUTE]	Crosses:	[INSERT]
Owner:	[STATE/TOWN]	Year Built:	[INSERT YEAR]
Maintained By:	[STATE/TOWN]	Year(s) Rebuilt/Rehab:	[INSERT YEAR(s)]

INVENTORY RATING LOAD (RI PERMIT LOADS)

BRIDGE COMPONENT	RI PERMIT TRUCKS (TONS)						
	RI-BP 1	RI-BP 2	RI-BP 3	RI-BP 4	RI-OP 1	RI-OP 2	RI-OP 3
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]

Figure 5. Load Rating Report Breakdown of Bridge Rating (Inventory for RI Permit Loads)

SUMMARY OF BRIDGE RATING (ASD or LFD)

Town/City:	[INSERT LOCATION]	Bridge No.:	[INSERT NO.]
Route Carried:	[INSERT ROUTE]	Crosses:	[INSERT]
Owner:	[STATE/TOWN]	Year Built:	[INSERT YEAR]
Maintained By:	[STATE/TOWN]	Year(s) Rebuilt/Rehab:	[INSERT YEAR(s)]

RATING

VEHICLE TYPE	RF (INV)	RF (OP)	POSTING
HS-20	[X]	[X]	---
H20	[X]	[X]	[X]
TYPE 3	[X]	[X]	[X]
TYPE 3S2	[X]	[X]	[X]
TYPE 3-3	[X]	[X]	[X]
SU 4	[X]	[X]	[X]
SU 5	[X]	[X]	[X]
SU 6	[X]	[X]	[X]
SU 7	[X]	[X]	[X]
RI-BP 1	[X]	[X]	[X]
RI-BP2	[X]	[X]	[X]
RI-BP 3	[X]	[X]	[X]
RI-BP 4	[X]	[X]	[X]
RI-OP1	[X]	[X]	[X]
RI-OP2	[X]	[X]	[X]
RI-OP3	[X]	[X]	[X]

Posting Analysis	
Posting Recommendation (Y/N):	
Governing RF:	

QA/QC	
Load Rating Engineer Name:	
Load Rating Engineer License #:	
Load Rating Engineer Signature:	
Load Rating Checked By:	
Quality Assurance By:	
Load Rating Date:	

Please check the following boxes that apply:

[ ] Bridge load rating is not governed by deck rating
[ ] Bridge load rating is not governed by substructure rating
[ ] Connections do not control the load rating
[ ] Exterior girder controls the load rating
[ ] Bridge plans do not exist; load rating based on judgement and current rating
[ ] As-built load rating
[ ] As-inspected load rating
[ ] Recommend Proof load test due to limited available information (Note: only if bridge requires posting)

Figure 6. Load Rating Report Summary of Bridge Rating (ASD or LFD)

BREAKDOWN OF BRIDGE RATING (LFD or ASD)

Town/City:	[INSERT LOCATION]	Bridge No.:	[INSERT NO.]
Route Carried:	[INSERT ROUTE]	Crosses:	[INSERT]
Owner:	[STATE/TOWN]	Year Built:	[INSERT YEAR]
Maintained By:	[STATE/TOWN]	Year(s) Rebuilt/Rehab:	[INSERT YEAR(s)]

INVENTORY RATING LOAD (TONS)

BRIDGE COMPONENT	DESIGN LOAD	LEGAL LOAD							
	(HS-20)	H20	TYPE 3	TYPE 3S2	TYPE 3-3	SU 4	SU 5	SU 6	SU 7
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]

INVENTORY RATING LOAD (TONS)

BRIDGE COMPONENT	RI PERMIT TRUCKS						
	RI-BP 1	RI-BP 2	RI-BP 3	RI-BP 4	RI-OP 1	RI-OP 2	RI-OP 3
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]

Figure 7. Load Rating Report Breakdown of Bridge Rating (ASD/LFD Inventory Ratings)

BREAKDOWN OF BRIDGE RATING (LFD or ASD)

Town/City:	[INSERT LOCATION]	Bridge No.:	[INSERT NO.]
Route Carried:	[INSERT ROUTE]	Crosses:	[INSERT]
Owner:	[STATE/TOWN]	Year Built:	[INSERT YEAR]
Maintained By:	[STATE/TOWN]	Year(s) Rebuilt/Rehab:	[INSERT YEAR(s)]

OPERATING RATING LOAD (TONS)

BRIDGE COMPONENT	DESIGN LOAD	LEGAL LOAD							
	(HS-20)	H20	TYPE 3	TYPE 3S2	TYPE 3-3	SU 4	SU 5	SU 6	SU 7
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]

OPERATING RATING LOAD (TONS)

BRIDGE COMPONENT	RI PERMIT TRUCKS						
	RI-BP 1	RI-BP 2	RI-BP 3	RI-BP 4	RI-OP 1	RI-OP 2	RI-OP 3
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
[ELEMENT] [LIMIT STATE] [ANALYZED LOCATION]	[X]	[X]	[X]	[X]	[X]	[X]	[X]

Figure 8. Load Rating Report Breakdown of Bridge Rating (ASD/LFD Operating Ratings)

DESCRIPTION OF BRIDGE

Bridge Number:	[BRIDGE NO.]
Owner:	[OWNER]
Maintained By:	[MAINTAINER]
Location:	[TOWN/CITY]
Route Carried:	[STREET]
Feature Intersected:	[FEATURED INTERSECTED]

Year Built & Inspection Dates:

Latest NBI Inspection Date:	[DATE]
Field Verification Date (if applicable):	[DATE]
Date of Construction:	[YEAR]
Bridge Type:	[TYPE]
Original Design Loading:	[TYPE]
Date(s) of Rebuild/Rehab:	[YEAR]
Description of Rebuild/Rehab:	[TYPE]
Posting:	[TYPE]

Design:

Superstructure:	[X]
Substructure:	[X]
Bearings:	[X]
Bridge Spans:	[TOTAL LENGTH & AMOUNT OF SPANS, LENGTH PER SPAN]
Bridge Skew:	[x°-xx'-x"]
Bridge Width:	[X'-XX"] out-to-out
Roadway Width:	[X'-XX"] curb-to-curb
Roadway Surface:	[X]
Curbs:	[X]
Sidewalk/Walkway/Median:	[X]
Utilities:	[X]
Bridge Railing:	[X]
Approach Railing:	[X]

Condition:

Wearing Surface Condition:	[X]
Bridge Railing Condition:	[X]
Deck Condition:	[X]
Beam Condition:	[X]
Bearing Condition:	[X]
Abutment Condition:	[X]
Pier Condition:	[X]

Figure 9. Load Rating Report Description of Bridge Rating (ASD/LFD Inventory Ratings)

5.2 QUALITY CONTROL AND QUALITY ASSURANCE REVIEW OF LOAD RATINGS

Quality control procedures are intended to maintain the quality of the bridge load ratings and are usually performed continuously within the load rating teams/units. When Consultants perform load ratings, the consultant shall have quality control procedures in place to assure the accuracy and completeness of the load ratings. All load rating calculations shall be checked by a qualified engineer other than the load rating engineer. Upon completion, the initials of the reviewer shall be placed on every sheet of the calculations.

When computer programs are used, the load rating engineer shall perform necessary independent checks to validate the accuracy of the load rating results generated by the program. The checker should verify all input data, verify that the summary of load capacity information accurately reflects the analysis, and be satisfied with the accuracy and suitability of the computer program.

Quality assurance procedures are used to verify the adequacy of the quality control procedures to meet or exceed the standards established by the agency or the consultant performing the load ratings. Quality assurance procedures are usually performed independent of the load rating teams on a sample of their work. Guidance on quality measures for load rating may be found in MBE Article 1.4.

5.3 QUALITY CONTROL OF LOAD POSTINGS

For Non-State owned or maintained structures, the Bridge Engineering Section of RIDOT may recommend load posting with concurrence from the District(town or city) in which the bridge is located. The State's recommendation shall contain the following statement "The town/city of _____________ shall notify the State in writing of its actions within 30 days of receipt of the State's posting recommendation."

Verification of the posting (or non-posting) shall be confirmed through the bridge inspection reporting. Weight limit signs shall conform to the requirements stated in the MBE.

5.4 BRASS INPUT FILE

For consistency in reviewing and updating Brass input files, RIDOT requires the following general command structure to be incorporated into all new load ratings:

- Description
- Output Commands
- Member Properties
- Span Description
- Live Load Distribution Factors
- Limit States & Load Factors
- LRFD Resistance & Condition Factors
- LRFD Code Specification
- Shear Connectors, Bracing, Lateral Support
- Points of Interest
- Dead Loads
- Live Load Impact
- Truck Loads

Command inputs for all truck loads shall be incorporated into each load rating in lieu of vehicle libraries due to inconsistencies between various live load libraries.

5.5 ELECTRONIC FILES

The information below provides the definitions and layout of the bridge load rating data file folder required to be submitted to RIDOT as part of the submittal. The folder should be labeled with the 6-digit bridge number containing a "Date of Rating Folder" (labeled as the 8 digit date of rating) and include both an "Input Folder" (with software input) and "Load Rating Report .pdf" as described below:

Bridge Number Folder: The parent folder for all bridge load rating data pertaining to a particular bridge. This folder includes the "Date of Rating Folder".

For example, Bridge No. 001101

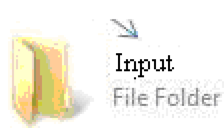
Date of Rating Folder: Bridge "date of rating" subfolder containing both "Input Folder" and "Load Rating Report pdf".

The "Date of Rating Folder" shall be named according to the following:

Bridge Rating Folder Filename Format: MM.DD.YYYY	
MM=	Month of inspection
DD=	Day of inspection
YY=	Year of inspection

For example, a Load Rating completed on 06/06/2009, the folder label shall be named 06.06.2009

Input: The input folder shall contain the Brass or other approved software input files labeled in a logical way. Refer to Section 5.4 for Brass input requirements:



Load Rating Report: A digital copy of the signed load rating shall be in pdf format and labeled with the 6 digit bridge number.

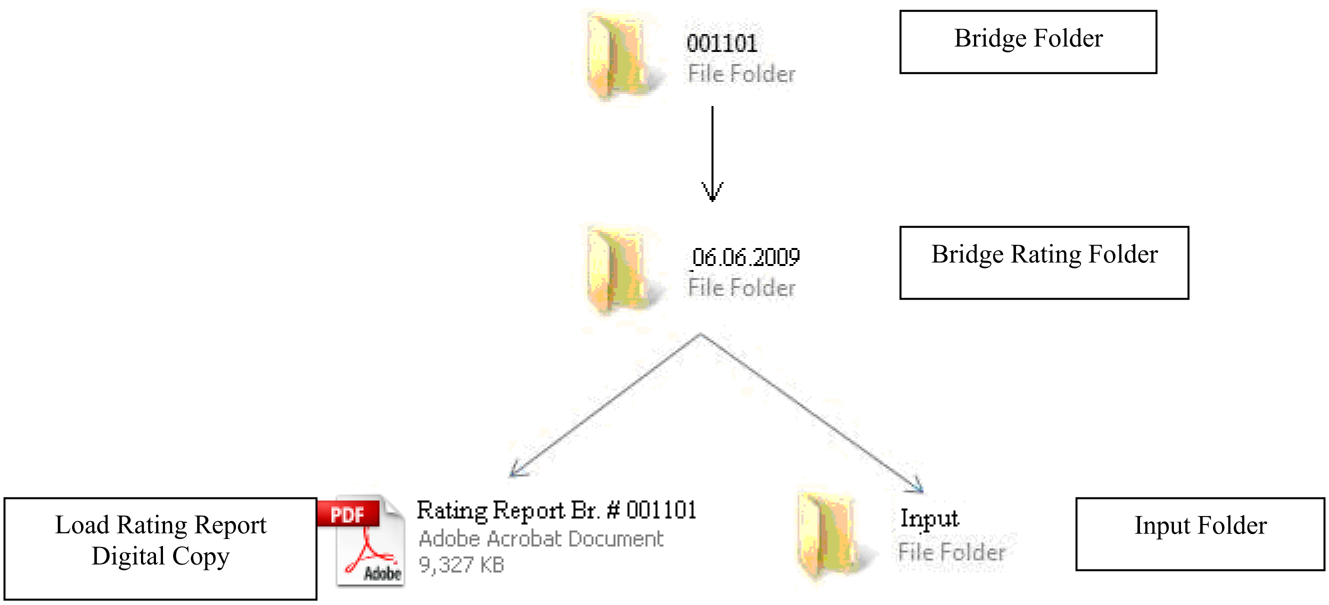


Figure 10. Electronic File Submission Layout

5.6 REFERENCE:

1. AASHTO *Manual for Bridge Evaluation,* First Edition (2008), including all latest revisions.

2. FHWA. 2002. *Bridge Inspector's Reference Manual (BIRM)*, Federal Highway Administration, U.S. Department of Transportation, Washington, DC.

3. AASHTO *LRFD Bridge Design Specifications*, 5th Edition (2010), including all latest revisions.

4. NCHRP Report 575, *Legal Truck Loads and AASHTO Legal Loads for Posting.*